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A Study of the Movements of the Empty Stomach in the Mollusca

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A STUDY OF THE MOVEMENTS OF THE EMPTY STOMACH IN THE MOLLUSCA

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Our knowledge concerning the variations of the gastric activity in the various animal groups is still very incomplete and this is notably true in the case of the invertebrates. The present investigation is limited to two species of marine and one specie of terrestrial mollusca, which in so far as I am aware, represents the first study to be made on the movements of the empty stomach in any of the invertebrates. Of the marine forms, the first is a large belly-footed animal or univalved shell-fish known as *Haliotis rufescens* (Abalone), while the second is a large chiton called *Cryptochiton stelleri,* both species of which are found on the California coast, in the vicinity of Monterey Bay. The land form, *Ariolimax Californicus,* known as the giant slug is found in San Mateo County, California only. The contractions in both the marine forms were recorded by the balloon method, the animals being kept in a large vivarium provided with running sea water, while the method of direct inspection was used on *Ariolimax.*

In *Haliotis,* an esophageal fistula was made about 5 cm. posterior to the mouth by simply raising the shell and making a small transverse incision laterally with scissors through the exposed wall of the esophagus. The balloon was introduced through this opening and pushed into the stomach and the rubber tube for the manometer then carried through one of the fissures (openings) in the shell (Figure 1). The contractions always started in twelve to fifteen minutes following this procedure and were continuous. However, a certain type of altered periodicity was noted as indicated by periods of marked activity separated by periods of strong hunger contractions, the individual contractions having comparatively long intervals of rest between them (Figure 2-B). In starvation, the gastric contractions progressively increased in strength until after about two weeks when they approached the form of incomplete tetanus (Figure 2-C). The introduction of sea-water, fresh tap water, 1 per cent sodium carbonate or 0.5 per cent hydrochloric acid directly into the stomach produced inhibition in varying degrees, the intensity being indicated in the order of the respective

substances as given, it being the least in the case of sea-water and the greatest with the acid.

In *Cryptochiton*, a fistula was found to be impracticable and it became necessary to use a glass stomato-gastric tube covered with rubber tubing. This was bent so as to fit into the mouth and then passed into the much folded stomach with the balloon attach to the end. The gastric contractions of this animal were also continuous with only a very slight indication of an altered periodicity. They appeared to be analogous with the twenty-second rhythm in man.

In *Ariolimax*, the method of direct inspection revealed that the movements of the empty stomach were peristaltic and corresponded fairly well in rate and duration with those of the marine forms when observed under constant temperature conditions.

Mechanical and chemical stimuli when externally applied to the sensory surfaces of these animals, as the mantle, epipodia, sense palps, etc., invariably produced temporary inhibition of the gastric hunger movements but its duration did not usually exceed greatly the duration of the actual stimulation unless it was severe (Figures 3 and 4-B).

A histological study of the alimentary tubes of *Haliotis* and of *Cryptochiton*, revealed their structures to be similar to those found in the alimentary canals of higher animals, with the exception that the circular muscular layer of the *Cryptochiton* is comparatively very thin and this is especially true of the cardiac end of the stomach.

Figure 1. Shows *Haliotis rufescens* (Abalone) with two rubber tubes passing through one of the fissures (openings) in the shell, to enter the esophageal fistula (not shown). The shorter tube, having a gastric balloon attached to the end, connects with a recording water manometer. The longer tube is for the introduction of fluids into the stomach to determine the effects of inhibition.

Figure 2. Gastric contractions of the stomach of *Haliotis rufescens*, A, normal digestive peristalsis. B, hunger peristalsis after a fast of ten days, showing the termination of a period of marked activity followed by strong hunger contractions, separated by comparatively long intervals of rest and indicative of an altered periodicity. C, hunger peristalsis after a fast of 16 days indicating an incomplete tetanus of the gastric mechanism.

Figure 3. Inhibition of the gastric contractions in *Haliotis rufescens* after a fast of ten days. At X, three of the sense palps were slightly pinched with forceps on the mid portion of the epipodium.

Figure 4. Gastric contractions of the stomach of *Cryptochiton stelleri*, A, hunger peristalsis after a fast of twenty days with a time record below in one second intervals. B, inhibition of hunger peristalsis after a fast of seventeen days. At X, ventral edge of mid-portion of mantle was slightly stimulated with a glass rod.

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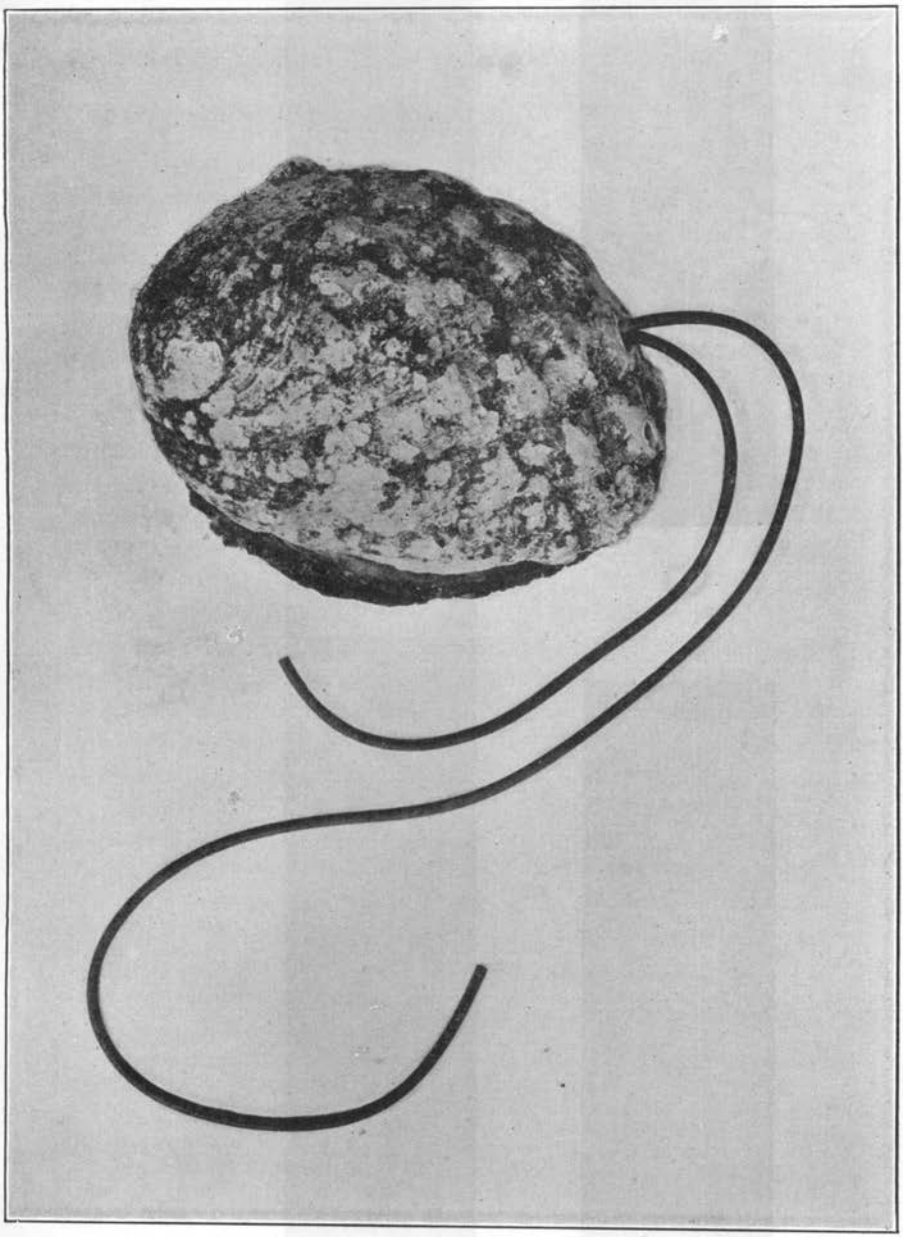
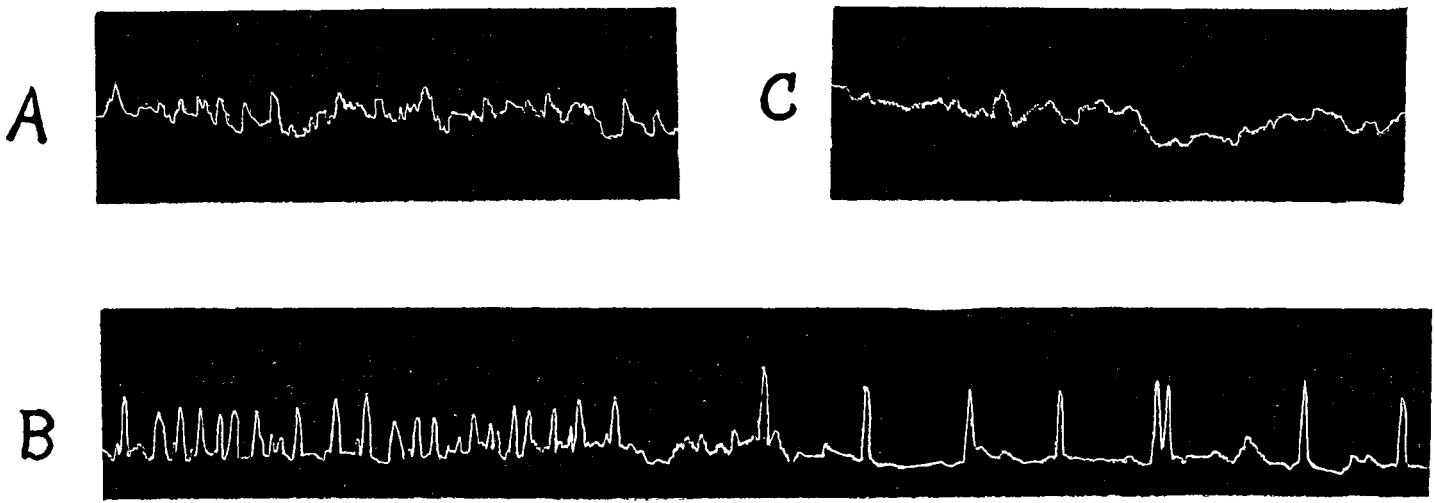


Figure 1.



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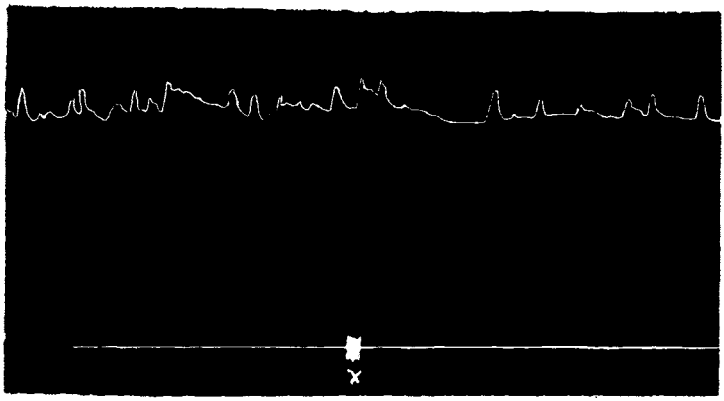

Figure 3.

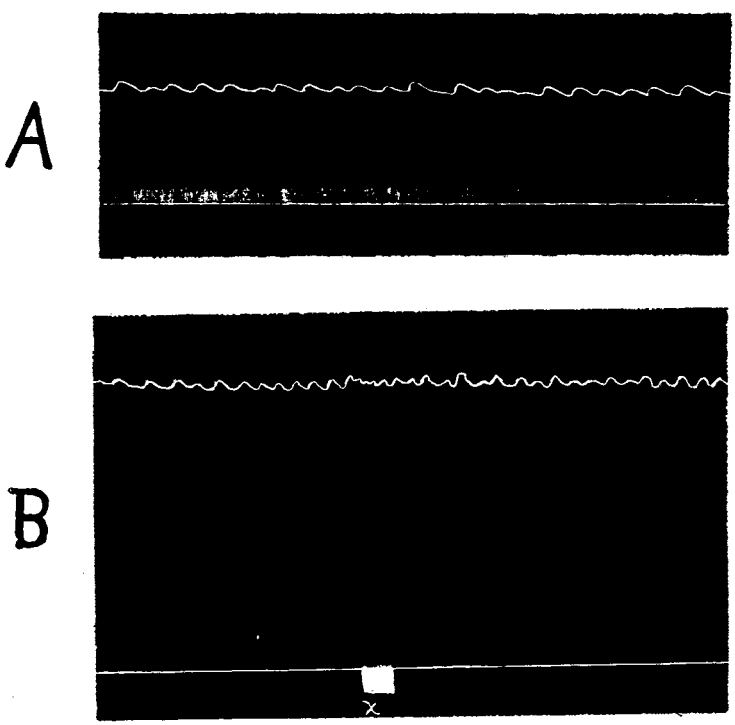

Figure 4.